

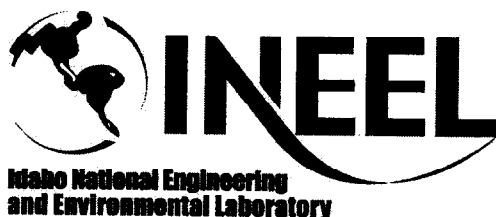
Engineering Design File

PROJECT FILE NO. 020996

Staging, Storage, Sizing and Treatment Facility

Decon Facility HVAC System

Prepared for:
U.S. Department of Energy
Idaho Operations Office
Idaho Falls, Idaho



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ENGINEERING DESIGN FILE

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PROJECT/TASK SSSTF - MINIMUM INFRASTRUCTURE

SUBTASK DECON FACILITY

EDF PAGE NO. 1 OF 13

TITLE **HVAC SYSTEM**

SUMMARY

GENERAL

This EDF contains the heating and ventilation calculations for the SSSTF Decon facility. Basis for the design contained in the subcontract drawings and specifications for this project are contained herein and in the listed applicable codes, standards, and requirements.

APPLICABLE CODES, STANDARDS, AND REQUIREMENTS

Calculations and information contained herein are in accordance with the requirements, criteria, recommended practices, or suggestions within the following codes, standards, and requirements.

1. DOE-ID Architectural Engineering Standards
2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers - ASHRAE
GRP-158 - Cooling and Heating Load Calculation Manual.
3. ERDA 76-21, Nuclear Air Cleaning Handbook.
4. American Conference of Governmental Industrial Hygienists - ACGIH
Industrial Ventilation, A Manual of Recommended Practice.
5. American Society of Heating, Refrigerating, and Air-Conditioning Engineers - ASHRAE
Std. 62-99, Ventilation for Acceptable Air Quality.

QUALITY LEVEL ☐ 1 ☐ 2 ☐ 3 ☒ 4

KEYWORDS (e.g. area, structure no., general subject matter, etc.):

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CHECKED *Based on Original* DATE
M. J. Pope for:
M. E. Van Sickle, P.E. *6 FEB. 2002*

APPROVED/ACCEPTED *Hurst* DATE
C. J. Hurst, P.E. *3/8/02*
E. C. Anderson, P.E. *3/8/02*

INDEPENDENT PEER REVIEWER DATE
Mark H. Doornbos *3/8/02*
M. H. Doornbos, P.E. *(QRB Chair)*

BBWI REQUESTOR DATE
R. L. Davidson *3/7/02*
R. L. Davidson

STAGING, STORAGE, SIZING, AND TREATMENT FACILITY (SSSTF)

DECON BUILDING HVAC DESIGN

1. DECON BAY

1.1 KEY HVAC CRITERIA

Ventilation Containment Criteria:Negative 0.1" w.g.
 Ventilation Flow Criteria:.....2 air changes per hour.
 Outdoor Heating Design Temperature:.....- 20 °F
 Outdoor Freeze Protection Design Temp.:- 40 °F
 Indoor Heating Design Temperature:.....+60 °F
 Indoor Freeze Protection Design Temp.:+40 °F
 Cooling:.....None Required

1.2 VENTILATION

$$q = (2 \text{ a.c./hr})(102.5 \text{ ft})(30.5 \text{ ft})(22 \text{ ft})(1 \text{ hr}/60 \text{ min/a.c.}) = \underline{2293 \text{ cfm}}$$

1.3 HEATING

$$Q_{\text{Cond}} = U A \partial T$$

$$U = 1/R$$

R = thermal resistance factor. Roof insulation is R-19. Wall insulation is R-16. Accounting parallel heat transfer paths for doors of R-5 or less, wall and roof steel structural elements, and floor slab losses, the resulting overall thermal resistance factor is reduced significantly. Buildings of this construction generally result in an overall thermal resistance factor of R-10.

Note: As seen below, the conduction heat transfer for this facility is less than 1/3 of the overall heat load. Therefore, the above approximation is justified.

$$U = (1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F})$$

$$A = (102.5 \text{ ft})(17 \text{ ft}) + (2)(30.5 \text{ ft})(22 \text{ ft}) + (102.5 \text{ ft})(32 \text{ ft}) = 6365 \text{ sf}$$

$$\partial T = 60 \text{ } ^\circ\text{F} - (-20 \text{ } ^\circ\text{F}) = 80 \text{ } ^\circ\text{F}$$

$$Q_{\text{Cond}} = [(1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F})](6365 \text{ sf})(80 \text{ } ^\circ\text{F}) = 50,916 \text{ btu/hr}$$

$$Q_{\text{oa}} = 0.93 \text{ cfm } \Delta T = (0.93)(2293 \text{ cfm})(80 \text{ }^{\circ}\text{F}) = 170,600 \text{ btu/hr}$$

Note: Infiltration is not a factor in this facility because of the nature of the exhaust system. The exhaust fan only pulls a given amount of air from the facility. Therefore, if all of that air is accounted for, no additional infiltration allowance is needed. Essentially, all of the outside air is infiltration.

$$Q_{\text{Total}} = 50,916 \text{ btu/hr} + 170,600 \text{ btu/hr} = (221,516 \text{ btu/hr})(1 \text{ kW} / 3412 \text{ btu/hr}) = \underline{65 \text{ kW}}$$

Use six Chromalox RBC-14 ceiling mount radiant heaters (13.5 kW each) for total of 81 kW heat available.

Freeze Protection Check: Heating design temperature difference (indoor to outdoor) is the same as freeze protection design temperature difference. Therefore, heating system is adequate for freeze protection to $-40 \text{ }^{\circ}\text{F}$.

2. TREATMENT AREA

2.1 KEY HVAC CRITERIA

Ventilation Containment Criteria:Negative 0.1" w.g.
 Ventilation Flow Criteria:Operating: 6 air changes per hour
 Outdoor Heating Design Temperature:- 20 °F
 Outdoor Freeze Protection Design Temp.:- 40 °F
 Indoor Heating Design Temperature:+60 °F
 Indoor Freeze Protection Design Temp.:+40 °F
 Cooling:None Required

2.2 VENTILATION

$$q = (6 \text{ a.c./hr})(51.5 \text{ ft})(30.5 \text{ ft})(22 \text{ ft})(1 \text{ hr}/60 \text{ min/a.c.}) = \underline{3456 \text{ cfm}}$$

2.3 HEATING

$$Q_{\text{Cond}} = U A \Delta T$$

$$U = 1/R = (1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F}) \text{ \{see explanation in section 1.3\}}$$

$$A = (51.5 \text{ ft})(17 \text{ ft}) + (30.5 \text{ ft})(22 \text{ ft}) + (51.5 \text{ ft})(32 \text{ ft}) = 3195 \text{ sf}$$

$$\Delta T = 60 \text{ } ^\circ\text{F} - (-20 \text{ } ^\circ\text{F}) = 80 \text{ } ^\circ\text{F}$$

$$Q_{\text{Cond}} = [(1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F})](3195 \text{ sf})(80 \text{ } ^\circ\text{F}) = 25,560 \text{ btu/hr}$$

$$Q_{\text{OA}} = 0.93 \text{ cfm } \Delta T = (0.93)(3456 \text{ cfm})(80 \text{ } ^\circ\text{F}) = 257,126 \text{ btu/hr \{see infiltration note in section 1.3\}}$$

$$Q_{\text{Total}} = 25,560 \text{ btu/hr} + 257,126 \text{ btu/hr} = (282,686 \text{ btu/hr})(1 \text{ kW} / 3412 \text{ btu/hr}) = \underline{83 \text{ kW}}$$

Use seven Chromalox RBC-14 ceiling mount radiant heaters (13.5 kW each) for total of 95 kW heat available.

Freeze Protection Check: Heating design temperature difference (indoor to outdoor) is the same as freeze protection design temperature difference. Therefore, heating system is adequate for freeze protection to -40 °F.

3. FIRE RISER ROOM

3.1 KEY HVAC CRITERIA

Ventilation Containment Criteria:None Required
Ventilation Flow Criteria:.....None Required – Not normally occupied.
Outdoor Heating Design Temperature:.....- 20 °F
Outdoor Freeze Protection Design Temp.:- 40 °F
Indoor Heating Design Temperature:.....+60 °F
Indoor Freeze Protection Design Temp.:+40 °F
Cooling:.....None Required

3.2 HEATING

$$Q_{\text{Cond}} = U A \Delta T$$

$$U = 1/R = (1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F}) \text{ \{see explanation in section 1.3\}}$$

$$A = (10 \text{ ft})(9 \text{ ft}) = 90 \text{ sf } \text{\{Outside wall only\}}$$

$$\Delta T = 60 \text{ } ^\circ\text{F} - (-20 \text{ } ^\circ\text{F}) = 80 \text{ } ^\circ\text{F}$$

$$Q_{\text{Cond}} = [(1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F})](90 \text{ sf})(80 \text{ } ^\circ\text{F}) = 720 \text{ btu/hr} = \underline{0.22 \text{ kW}}$$

Use one Chromalox SKR-2083 fixed element radiant heater with 0.8 kW total heat available.

Freeze Protection Check: Heating design temperature difference (indoor to outdoor) is the same as freeze protection design temperature difference. Therefore, heating system is adequate for freeze protection to -40 °F.

4. ELECTRICAL ROOM

4.1 KEY HVAC CRITERIA

Ventilation Containment Criteria:None Required
Ventilation Flow Criteria:.....None Required – Not normally occupied.
Outdoor Heating Design Temperature:.....- 20 °F
Outdoor Freeze Protection Design Temp.:- 40 °F
Indoor Heating Design Temperature:.....+60 °F
Indoor Freeze Protection Design Temp.:+40 °F
Cooling:.....None Required

4.2 HEATING

$$Q_{\text{Cond}} = U A \partial T$$

$$U = 1/R = (1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F}) \text{ \{see explanation in section 1.3\}}$$

$$A = (10 \text{ ft})(9 \text{ ft}) + (8 \text{ ft})(9 \text{ ft}) = 162 \text{ sf} \text{ \{Outside walls only\}}$$

$$\partial T = 60 \text{ } ^\circ\text{F} - (-20 \text{ } ^\circ\text{F}) = 80 \text{ } ^\circ\text{F}$$

$$Q_{\text{Cond}} = [(1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F})](162 \text{ sf})(80 \text{ } ^\circ\text{F}) = 1296 \text{ btu/hr} = \underline{0.38 \text{ kW}}$$

Use one Chromalox SKR-2083 fixed element radiant heater with 0.8 kW total heat available.

Freeze Protection Check: Heating design temperature difference (indoor to outdoor) is the same as freeze protection design temperature difference. Therefore, heating system is adequate for freeze protection to -40 °F.

5. CHANGE ROOM (DON/DOFF ROOM)

5.1 KEY HVAC CRITERIA

Ventilation Containment Criteria:Negative w.r.t. hall, positive w.r.t. decon/treatment.
Ventilation Flow Criteria:2 air changes per hour.
25 cfm/person
Outdoor Heating Design Temperature:- 20 °F
Outdoor Freeze Protection Design Temp.:- 40 °F
Indoor Heating Design Temperature:+72 °F
Indoor Freeze Protection Design Temp.:+40 °F
Cooling:None Required

5.2 VENTILATION

$$q = (2 \text{ a.c./hr})(10 \text{ ft})(16 \text{ ft})(9 \text{ ft})(1 \text{ hr}/60 \text{ min/a.c.}) = 48 \text{ cfm}$$

$$q = (25 \text{ cfm/person})(2 \text{ people}) = \underline{50 \text{ cfm}}$$

5.3 HEATING

As all walls and ceiling interface conditioned spaces, conduction heat transfer is minimal. Heat transfer is only to adjoining 60 °F conditioned spaces.

Supply air to this room is through the adjoining conditioned hallway.

Use one Chromalox SKR-2083 fixed element radiant heater with 0.8 kW total heat available.

6. RADCON ROOM

6.1 KEY HVAC CRITERIA

Ventilation Containment Criteria:Negative w.r.t. hall.
Ventilation Flow Criteria:.....2 air changes per hour.
25 cfm/person.
Outdoor Heating Design Temperature:- 20 °F
Outdoor Freeze Protection Design Temp.:- 40 °F
Indoor Heating Design Temperature:.....+72 °F
Indoor Freeze Protection Design Temp.:+40 °F
Cooling:.....None Required

6.2 VENTILATION

$$q = (2 \text{ a.c./hr})(10 \text{ ft})(16 \text{ ft})(9 \text{ ft})(1 \text{ hr}/60 \text{ min/a.c.}) = 48 \text{ cfm}$$

$$q = (25 \text{ cfm/person})(2 \text{ people}) = \underline{50 \text{ cfm}}$$

6.3 HEATING

$$Q_{\text{Cond}} = U A \Delta T$$

$$U = 1/R = (1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F}) \quad \{\text{see explanation in section 1.3}\}$$

$$A = (10 \text{ ft})(9 \text{ ft}) = 90 \text{ sf} \quad \{\text{Outside wall only}\}$$

$$\Delta T = 72\text{ }^{\circ}\text{F} - (-20\text{ }^{\circ}\text{F}) = 92\text{ }^{\circ}\text{F}$$

$$Q_{\text{cond}} = [(1 \text{ btu}) / (10 \text{ hr ft } ^\circ\text{F})] (90 \text{ sf}) (92 \text{ } ^\circ\text{F}) = 828 \text{ btu/hr} = 0.24 \text{ kW}$$

Supply air is from conditioned hallway.

Use one Chromalox SKR-2083 fixed element radiant heater with 0.8 kW total heat available.

7. MEN'S LOCKER

7.1 KEY HVAC CRITERIA

Ventilation Containment Criteria:Inflow only
Ventilation Flow Criteria:2 cfm/sf
Outdoor Heating Design Temperature: - 20 °F
Outdoor Freeze Protection Design Temp.: - 40 °F
Indoor Heating Design Temperature:+72 °F
Indoor Freeze Protection Design Temp.:+40 °F
Cooling:None Required

7.2 VENTILATION

$$q = (2 \text{ cfm/sf})(16 \text{ ft})(25 \text{ ft}) = \underline{800 \text{ cfm}}$$

7.3 HEATING

$$Q_{\text{cond}} = U A \partial T$$

$$U = 1/R = (1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F}) \text{ \{see explanation in section 1.3\}}$$

$$A = (18 \text{ ft})(9 \text{ ft}) = 162 \text{ sf } \text{\{Outside wall only\}}$$

$$\partial T = 72 \text{ } ^\circ\text{F} - (-20 \text{ } ^\circ\text{F}) = 92 \text{ } ^\circ\text{F}$$

$$Q_{\text{cond}} = [(1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F})](162 \text{ sf})(92 \text{ } ^\circ\text{F}) = 1490 \text{ btu/hr} = 0.44 \text{ kW}$$

Supply air is from conditioned plenum.

Use one Chromalox SKR-2083 fixed element radiant heater with 0.8 kW total heat available.

Freeze Protection Check: Heating design temperature difference (indoor to outdoor) is greater than the freeze protection design temperature difference. Therefore, heating system is adequate for freeze protection to -40 °F.

8. WOMEN'S LOCKER

8.1 KEY HVAC CRITERIA

Ventilation Containment Criteria:Inflow only
Ventilation Flow Criteria:2 cfm/sf
Outdoor Heating Design Temperature:- 20 °F
Outdoor Freeze Protection Design Temp.:- 40 °F
Indoor Heating Design Temperature:+72 °F
Indoor Freeze Protection Design Temp.:+40 °F
Cooling:None Required

8.2 VENTILATION

$$q = (2\text{cfm/sf})(16\text{ ft})(25\text{ ft}) = \underline{800\text{ cfm}}$$

8.3 HEATING

$$Q_{\text{Cond}} = U A \Delta T$$

$$U = 1/R = (1\text{ btu})/(10\text{ hr ft }^{\circ}\text{F}) \text{ \{see explanation in section 1.3\}}$$

$$A = (18\text{ ft})(9\text{ ft}) = 162\text{ sf} \text{ \{Outside wall only\}}$$

$$\Delta T = 72\text{ }^{\circ}\text{F} - (-20\text{ }^{\circ}\text{F}) = 92\text{ }^{\circ}\text{F}$$

$$Q_{\text{Cond}} = [(1\text{ btu})/(10\text{ hr ft }^{\circ}\text{F})](162\text{ sf})(92\text{ }^{\circ}\text{F}) = 1490\text{ btu/hr} = 0.44\text{ kW}$$

Supply air is from conditioned plenum.

Use one Chromalox SKR-2083 fixed element radiant heater with 0.8 kW total heat available.

Freeze Protection Check: Heating design temperature difference (indoor to outdoor) is greater than the freeze protection design temperature difference. Therefore, heating system is adequate for freeze protection to -40 °F.

9. JANITOR'S CLOSET

9.1 KEY HVAC CRITERIA

Ventilation Containment Criteria:Inflow only
Ventilation Flow Criteria:2 cfm/sf
Outdoor Heating Design Temperature:- 20 °F
Outdoor Freeze Protection Design Temp.:- 40 °F
Indoor Heating Design Temperature:+72 °F
Indoor Freeze Protection Design Temp.:+40 °F
Cooling:None Required

9.2 VENTILATION

$$q = (2\text{cfm/sf})(8\text{ ft})(8\text{ ft}) = \underline{128\text{ cfm}}$$

9.3 HEATING

Janitor's closet is surrounded by conditioned spaces and all supply air is through the conditioned hallway. Therefore, no supplemental heating is required.

10. HALLWAY

10.1 KEY HVAC CRITERIA

Ventilation Flow Criteria:.....None Required
Outdoor Heating Design Temperature:.....- 20 °F
Outdoor Freeze Protection Design Temp.:- 40 °F
Indoor Heating Design Temperature:.....+72 °F
Indoor Freeze Protection Design Temp.:+40 °F
Cooling:.....None Required

10.2 HEATING

$$Q_{\text{Cond}} = U A \Delta T$$

$$U = 1/R = (1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F}) \text{ \{see explanation in section 1.3\}}$$

$$A = (2)(5 \text{ ft})(9 \text{ ft}) = 90 \text{ sf } \text{\{Outside walls only\}}$$

$$\Delta T = 72 \text{ } ^\circ\text{F} - (-20 \text{ } ^\circ\text{F}) = 92 \text{ } ^\circ\text{F}$$

$$Q_{\text{Cond}} = [(1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F})](90 \text{ sf})(92 \text{ } ^\circ\text{F}) = 828 \text{ btu/hr} = 0.25 \text{ kW}$$

Supply air is from conditioned plenum.

Use two Chromalox SKR-2083 fixed element radiant heaters (one at each outside door) with 0.8 kW heat available each.

Freeze Protection Check: Heating design temperature difference (indoor to outdoor) is greater than the freeze protection design temperature difference. Therefore, heating system is adequate for freeze protection to -40 °F.

11. PLENUM

11.1 KEY HVAC CRITERIA

Ventilation Flow Criteria:.....Outside air as makeup to spaces below.
 Outdoor Heating Design Temperature:.....- 20 °F
 Outdoor Freeze Protection Design Temp.:- 40 °F
 Indoor Heating Design Temperature:.....+72 °F
 Indoor Freeze Protection Design Temp.:+40 °F
 Cooling:.....None Required

11.2 VENTILATION

$q = q(\text{changeroom}) + q(\text{radcon room}) + q(\text{men's locker}) + q(\text{women's locker}) + q(\text{janitor closet})$

$q = 50 \text{ cfm} + 50 \text{ cfm} + 800 \text{ cfm} + 800 \text{ cfm} + 128 \text{ cfm} = \underline{1828 \text{ CFM}}$

11.3 HEATING

$$Q_{\text{cond}} = U A \Delta T$$

$$U = 1/R = (1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F}) \text{ \{see explanation in section 1.3\}}$$

$$A = (52 \text{ ft})(8 \text{ ft}) + (30.5 \text{ ft})(8 \text{ ft}) + (52 \text{ ft})(32 \text{ ft}) = 2324 \text{ sf}$$

$$\Delta T = 72 \text{ } ^\circ\text{F} - (-20 \text{ } ^\circ\text{F}) = 92 \text{ } ^\circ\text{F}$$

$$Q_{\text{cond}} = [(1 \text{ btu})/(10 \text{ hr ft } ^\circ\text{F})](2324 \text{ sf})(92 \text{ } ^\circ\text{F}) = 21,380 \text{ btu/hr}$$

$$Q_{\text{oa}} = 0.93 \text{ cfm } \Delta T = (0.93)(1828 \text{ cfm})(92 \text{ } ^\circ\text{F}) = 156,404 \text{ btu/hr \{see infiltration note in section 1.3\}}$$

$$Q_{\text{total}} = 21,380 \text{ btu/hr} + 156,404 \text{ btu/hr} = 177,784 \text{ btu/hr} = \underline{53 \text{ kW}}$$

Use two Chromalox KUH unit heaters at 30 kW each for total of 60 kW heat available.

Freeze Protection Check: Heating design temperature difference (indoor to outdoor) is greater than the freeze protection design temperature difference. Therefore, heating system is adequate for freeze protection to -40 °F.